International Living With a Star
Activity in Ukraine

International living with the star (ILWS) program major goal is Space Weather (SW) monitoring and forecast - an actual challenge nowadays. The Sun is a variable star. Its brightness changes constantly, especially in invisible ultraviolet and x-ray wavelengths. This star generates stormy gusts in the solar wind that continually barrage the Earth's magnetic field. Rapid variations of solar wind can disrupt communications and navigation, damage satellites, interrupt power distribution on Earth, and affect astronauts and even aircraft passengers (Slide 1). Slower changes contribute to climate change as well. Therefore they need to be studied in much more detail.

The organization of efficiently operating monitoring system needs the development of coordinated research in this branch and establishment of new kind of partnership in R&D between scientists in order to coordinate the activities that traditionally fall within separate domains.

The SW R&D recently is intensely developed in Ukraine and is the main topic of international collaboration for Ukraine, which, having considerable scientific and technological potential in space research, also is ready to participate in this program with the following contribution.

It is known that in order to have efficiently operating SW monitoring system it is necessary to have the corresponding data both from the far space, ionosphere and from the ground stations.

All these three stages of the SW monitoring are under the development in Ukraine. First, the ground based support for solar activity study is realized already at several scientific institutions of Ukraine (Slide 2). The leading role plays Main Astronomic Observatory of National Academy of Sciences of Ukraine (NASU) in Kyiv with its departments in Crimea and Caucasus mountains. The Observatory is well known by its solar studies made both from the Earth surface and recently onboard "Coronas" space mission. Besides this Observatory, long-term successful experience of cooperative research in Solar physics have Crimean Astrophysical Observatory of NASU, Kharkiv National University and Astronomic Observatory of Kyiv National University which collaborate already several decades. Their main activity is concentrated on collective processes in active parts of Solar atmosphere and Solar wind model development. National Center of Space Systems Control and Research of National Space Agency of Ukraine (NSAU) is engaged in the study of the Sun in radiowaves band and now is working on the tracing of Solar mass ejections into the near-Sun and interplanetary space. Then it is the Radioastronomy Institute of NASU (Kharkiv), which has a unique decametric radiotelescope "URAN" able to operate in the interferometer mode with its sections situated in Ukraine (Lviv, Odessa) and with the partners abroad.

Next stage - continuous observations for magnetospheric and ionospheric processes monitoring - is realized in the modern electromagnetic observatory operating at Ukrainian Antarctic station "Akademik Vernadsky" (Slide 3). Due to exclusively clean electromagnetic environment there, it became possible to carry out the observations at the lowest possible electromagnetic sensors sensitivity threshold. Several new physical effects are already detected there and theoretically explained. This observatory is practically ready for SW program participation. The only problem, which has to be solved there, is reliable real-time data transmission to the selected data center.

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Also spatial segment engaged in SW study is under preparation now. At the end of the year 2004 the Ukrainian remote sensing satellite “SICH-1M” will be launched into polar sun-synchronous orbit (altitude ~ 650 km) with the specialized scientific electromagnetic equipment “variant” onboard. This will allow receiving regular operative information about the ionosphere conditions. The theoretical background and corresponding facilities are already created in Space Research Institute of NASU and NSAU for these data processing. The plasma dynamics is studied there, as well as wave processes in near-Earth space, high-energy particles interaction with Earth magnetosphere and magnetospheric substorms onset mechanism. Together with Kyiv National university the physical processes modeling in the system “Litosphere-Atmosphere-Ionosphere-Magnetosphere” (laim) of the Earth is executed with the account of solar activity. The Institute of Ionosphere of NASU (Kharkiv) is dealing with the study of ionospheric storms onset mechanism during solar flares.

Other ionospheric experiments dedicated to SW program are also under realization. First, this is Russian-Ukrainian “ENVIRONMENT” (obstanovka) mission aimed at the continuous monitoring of electromagnetic state of the ionosphere onboard Russian segment of International Space Station. The engineering models are already made and the foreseen launch date is 2006.

It is known that ISS is rather noisy space object and there is a little hope to get the reliable results of the measurements of low level electromagnetic signals produced by ionospheric disturbances related to SW. That is why a new Russian-Ukrainian experiment aimed at SW effects observations in ionosphere is accepted. The experiment will be realized onboard microsatellite chibis which is under development now at Space Research Institute of Russian Academy of Sciences. It will be launched in 2006 at the independent orbit about 500 km high using ISS infrastructure. The developed in Russia and Ukraine scientific payload for this satellite will allow to measure all set of electromagnetic parameters of the ionosphere responsible for SW effects.

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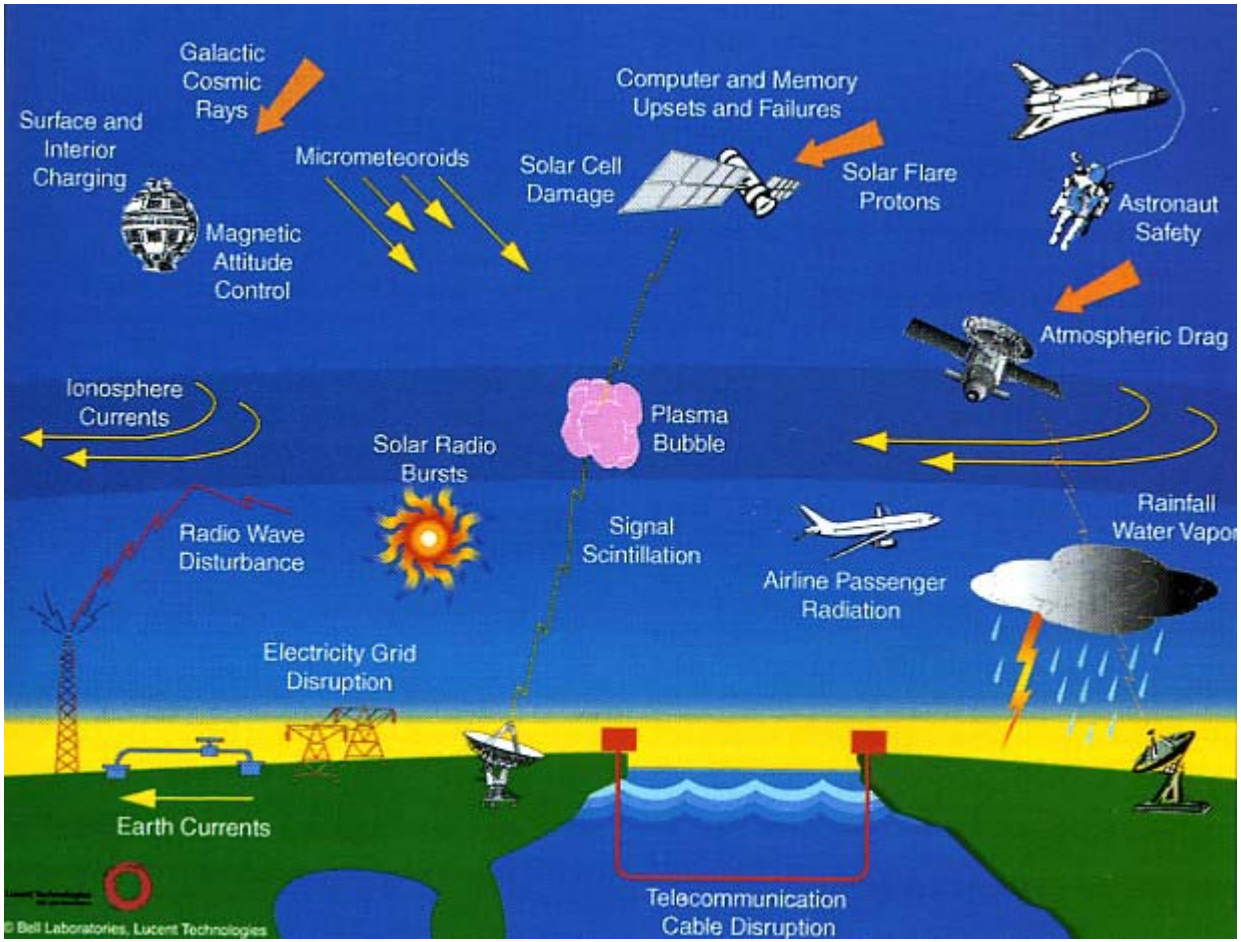
The ground based observation sites together with LEO satellites have to help also in the understanding of the impact of Earth generated processes upon the ionosphere (Slide 4). This influence cannot be ignored in conceptual space weather model and its study can help us in the solution of very important modern problem: monitoring of human activity (e.g., intense power consuming and CO_2 producing enterprises) and natural hazards (e.g., thunderstorm activity, earthquake preparation processes) from LEO satellites. The key questions here are the mechanism of the transport of energy released into Earth's lithosphere and in neutral atmosphere to the terrestrial plasma and the methodology of separation in the ionosphere of the effects "from top" and "from bottom".

The most distant part – observations in solar wind far away from the Earth – is planned to realize in frames of Russian-Ukrainian spatial experiment "Interball-prognoz" (tentative launch date - year 2008). This experiment is especially aimed at the SW program and foresees the synchronized operation of one satellite at Lagrange point L1 (Russian responsibility with possible Brazilian participation) and of a cluster of 3 micro-satellites at sun-synchronous orbit (Ukrainian responsibility with international participation).

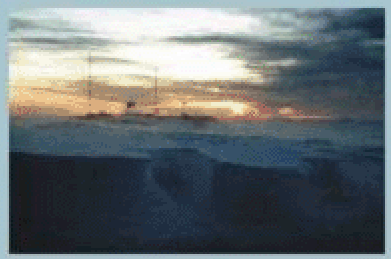
Expected deliverables of the ILWS R&D activity in Ukraine are:

1. Permanently operating ground monitoring systems in Ukraine and Antarctica with reliable links to sweNet.
2. Spatial experiments variant, environment and chibis data concerning SW problems free dissemination open for public.
3. Model of basic physical processes in the system "Lithosphere – Atmosphere – Ionosphere – Magnetosphere" allowing to discriminate "terragenic" and spatial sources of ionospheric disturbances.
4. Recommendations as to creation of global system of natural hazards and environmental monitoring as contribution to ILWS program.

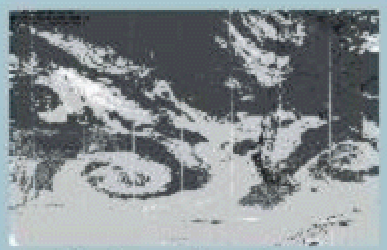
Space Weather influence



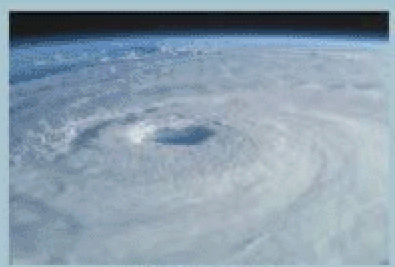
Atmospheric - space weather interactions



Weather front



Cyclone structures



Hurricane

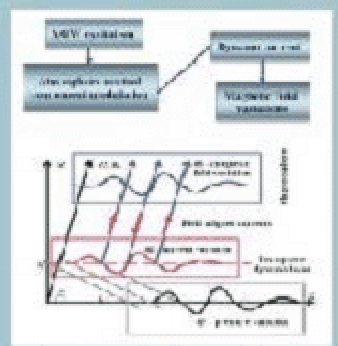
Impact of seismic and meteo events

Effect of atmospheric fronts on EM and plasma parameters

Cyclone - stimulated magnetic effects in conjugate areas

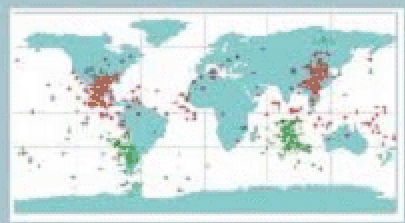
Global thunderstorms - plasma environment

Effect of acoustic disturbances on upper atmosphere



Chain of interactions

UAC "Academik Vernadsky"



Recovered global lightning activity

Powerful acoustic sounder

Solar activity solar wind

Optical, SHF, VHF, HF range observations of solar radiation

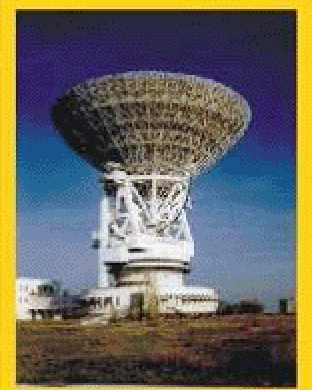
Solar VHF/HF radar

Coronal mass ejections - sporadic e/m emissions

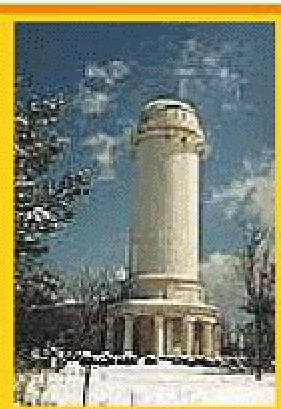
Model development to forecast activity

Scintillations in solar wind

Cosmic rays and radiation belts



RT-70



TST

Cosmic ray detectors

Terskol

UTR-2

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Ionosphere & Magnetosphere

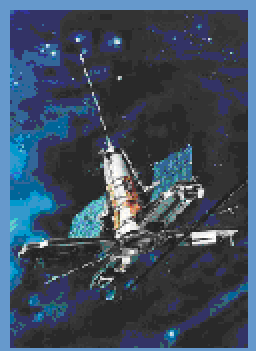
Geomagnetic observations in Antarctica

Geomagnetic observations in Ukraine

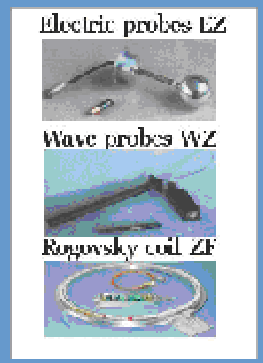
EM measurements from spacecraft

EM fields - plasma interactions

Geomagnetic disturbances modelling and forecasting

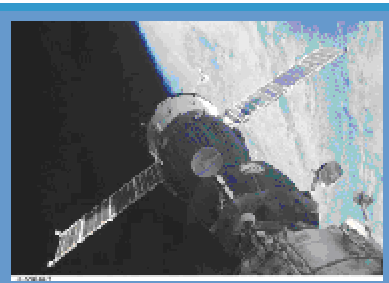


Sich-1M "Variant"

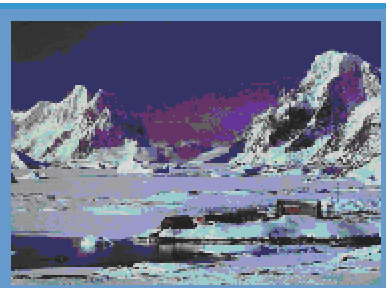


Payload "Variant"

Magnetic observatory AIA in Antarctica



ISS "Obstanovka"



Antarctic station

Payload "Variant"